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[Title of the Invention] AUTOMOBILE ON-BOARD AND/OR PORTABLE TELEPHONE SYSTEM

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[Number of General Power]	9 0 0 4 8 4 3	

[Title of Document] Specification

[Title of the Invention] AUTOMOBILE ON-BOARD AND/OR PORTABLE TELEPHONE SYSTEM

[Scope of Claim for a Patent]

[Claim 1] An automobile on-board and/or portable telephone system characterized by comprising:

units at transmitter side serving as a base station having spread modulation means for performing spread processings of user information in accordance with spread code corresponding to a channel number assigned to its user, and combining means for synthesis and transmission delivery of information subject to spread processings; and

units at receiver side having despread means for performing despread processings of the information subject to spread processings in accordance with the spread code corresponding to the channel number assigned to the user,

wherein spread code obtained by multiplying orthogonal spread code (number of codes: m) by a pseudo-random noise series are assigned to individual channels in the same cell, while upon assignment of the spread code, corresponding to the case where a rate smaller than the presently existing rate is used as an information transmission bit rate, spread codes

resulting from multiplication of m orthogonal spread codes by a first pseudo-random noise series are assigned to channel numbers #1 to #m and spread codes resulting from multiplication of said m orthogonal spread codes by a second pseudo-random noise series being of the same series as said first pseudo-random noise series but having a time phase which differs from that of said first pseudo-random noise series by a constant time are assigned to channel numbers #(m+1) to #2m, thereby making it possible to maintain the number of channels in the same cell at a value which is larger than the number of codes of the orthogonal spread code.

[Claim 2] An automobile on-board and/or portable telephone system according to claim 1 characterized in that the number of channels in the same cell is maintained at a larger value by doubling, tripling the number of the orthogonal spread code in a unit of multiple.

[Claim 3] An automobile on-board and/or portable telephone system according to claim 1 characterized in that said base station decides a maximum value of the number of link paths which can be generated simultaneously in said cell on the basis of transmission bit rates of user information on set link paths and permits setting of user link paths within the maximum value.

[Claim 4] An automobile on-board and/or portable telephone system according to claim 1 or 2 characterized

in that decision of the maximum value of link paths settable simultaneously is carried out by setting an upper limit to the sum of information transmission bit rates for individual users in the cell.

[Detailed Description of the Invention]

[0001]

[Technical Field Pertinent to the Invention]

The present invention relates to an automobile on-board and/or portable telephone system in which the number of channels can be increased easily.

[0002]

[Prior Art]

In recent years, automobile on-board and/or portable telephone systems of code division multiple access type have been developed for practical use as described in a paper "On the System Design Aspects of Code Division Multiple Access (CDMA) Applied to Digital Cellular and Personal Communications Networks (1992, Vehicular Technology Conference)". A conventional example of the construction of the automobile on-board and/or portable telephone system of the code division multiple access type is shown in Fig. 3. In the Figure, reference numeral 1 designates units at the transmitter side such as a base station and 2 units at the receiver side such as an automobile on-board telephone or a portable telephone. Denoted by reference numerals 3, 4

and 5 are information input lines which are provided, in the units at the transmitter side 1, in correspondence to channel numbers assigned to individual users and to which information from the individual users is inputted, the information input line 3 corresponding to channel number #1, the information input line 4 corresponding to channel number #2 and the information input line 5 corresponding to channel number #3. Reference numerals 6, 7 and 8 designate spread modulators connected to the information input lines 3, 4 and 5, respectively, and operative to perform spread processings in accordance with spread code corresponding to the individual channel numbers, and reference numeral 9 designates a combiner for synthesis and transmission of spread signals of a plurality of users. Denoted by reference numerals 10 is an despreader adapted to perform, in the units at the receiver side 2, a despread processing in accordance with a spread code of a channel assigned to each user.

In the units at the transmitter side 1, the spread modulators 6, 7 and 8 are supplied with parameters W1(t), W2(t) and Wm(t) representative of orthogonal spread codes, respectively, and a parameter PN(t) representative of a pseudo-random noise series, and the orthogonal spread code are multiplied by the pseudo-random noise series to produce spread codes corresponding to the individual channels and spread processings are carried out in accordance with the

spread codes. In the following description, the pseudo-random noise series is referred to as "PN" series. In the units at the receiver side 2, each equipment has an despreader 10 and when the channel number of the units at the receiver side 2 shown in Fig. 3 is #1, that despreader 10 is supplied with a parameter Wi(t) representative of an orthogonal spread code and the parameter PN(t) representative of the PN series to perform a despread processing in accordance with a spread code corresponding to that channel. To perform the spread and despread processings as above, spread codes as exemplified in Fig. 4 are used inside a certain cell in correspondence to channel numbers assigned to individual users.

[0003]

In the automobile on-board and/or portable telephone system constructed as above, when user information is inputted from each information input line 3, 4 or 5 at a predetermined information transmission bit rate (for example, B[bps]), a spread processing is carried out, in the units at the transmittor side 1, by the spread modulator 6, 7 or 8 in accordance with a spread code corresponding to a channel number assigned to a user of interest and then spread signals of a plurality of users are combined in the combiner 9 and transmitted. On the other hand, when a combined spread signal is received in the units at the receiver side 2,

the combined spread signal is subjected to a despread processing by the despreader 10 in accordance with a spread code of a channel number assigned to each user to reproduce the information at the information transmission bit rate B[bps] and the reproduced information is delivered out through an information output line 11.

[0004]

Waveforms are changed as shown in Figs. 5 to 7 when a signal representative of user information received at a certain information transmission bit rate is subjected to a spread processing, transmitted and then subjected to despread. The user information inputted from the information input line 3, 4 or 5 has the form of a spectrum signal 12 having a bandwidth of B and a power spectrum density of P. When this spectrum signal 12 undergoes a spread processing in the spread modulator 6, 7 or 8, power in the bandwidth B is spread to a spread bandwidth S of a spread multiplexed spectrum on a link path as shown in Fig. 6 to provide a spread signal 13 as shown in Fig. 6. Since the spread modulators 6, 7 and 8 correspond to channel numbers assigned to the individual users and the spread code are set to different values in correspondence to the respective channel numbers as shown in Fig. 4, the spread signal 13 differs from channel to channel to assume a multiplexed structure. Fig. 6 shows an example of 4-channel spread multiplexed spectrum.

[0005]

When the spread signal 13 as above is subjected to a despread processing in the units at the receiver side 2, the despread processing is carried out in the units at the receiver side 2 under the condition that the orthogonal spread code is Wi(t) and the PN series is PN(t) and consequently, of the 4-channel spread multiple spectrum, a spread signal of a channel corresponding to this spread code, that is, power of a desired wave 14 is again concentrated to the bandwidth B and multiplexed signals of the other users (for three channels) remain to be spread waveforms which exist as interference waves 15. Then when the multiplexed spectrum is filtered to pass the band B in the units at the receiver side 2, there result a desired wave 14 subject to the despread and a spectrum of interference wave 15. As long as SIR (signal to interference ratio), which is the ratio between power of the desired wave 14 and power of the interference wave 15, can be maintained at a predetermined value, necessary quality of communication can be maintained.

[0006]

To add, when B=9600, that is, the information transmission bit rate is 9600 bps, a maximum of 64 channels can be set within a range in which the SIR can be maintained at a predetermined value from the viewpoint of coping with the interference and there is

available an example of an automobile on-board and/or portable telephone system using 64 kinds of Walsh codes representative of orthogonal spread code.

[0007]

[Problem to be solved by the Invention]

In the aforementioned conventional automobile on-board and/or portable telephone system, however, the maximum channel of the outbound link path (a link path bound from the base station to an automobile on-board telephone or a portable telephone) in one cell is limited to the number of orthogonal spread codes (assuming m) and for example, even when a voice signal codec having a rate which is half the presently existing rate becomes applicable in the future in the field of communication, there will be a disadvantage that the capacity of subscribers cannot be increased because of shortage of the number of assigned codes or series in spite of the fact that link paths in excess of m channels are set up in one cell from the viewpoint of the necessary SIR and the requisite quality can be maintained for performing communication.

[0008]

More specifically, in the case where the information transmission bit rate is, for example, halved, the bandwidth becomes B/2 in a signal spectrum 16 of user information as shown in Fig. 8 and when this spectrum signal 16 having a power spectrum density of P_0

is subjected to a spread processing by the spread modulator 6, 7 or 8, power inside the bandwidth B/2 is spread to a spread bandwidth S of spread multiplexed spectrum on link path of Fig. 9 and there results a spread signal 17 as shown in Fig. 9. Since as described previously the spread modulators 6, 7 and 8 are set with values of spread code which are different for channel numbers, the spread signal 17 differs for the individual channels and has a multiplexed structure. Fig. 9 shows an example of a 7-channel spread multiplexed spectrum.

[0009]

When the spread signal 17 is subjected to a despread processing in the units at the receiver side 2, the despreader 10 performs the despread processing in accordance with Wi(t) representative of the orthogonal spread code and the PN(t) representative of the PN series and consequently, of the 7-channel spread multiplexed spectrum, a spread signal corresponding to this spread code, that is, power of a desired wave 18 is again concentrated to the bandwidth B/2 and the multiplexed signals of the other users (for 6 channels) remain to be spread waveforms which exist as interference waves 19. Then when the multiplexed spectrum is filtered to pass the band B in the units at the receiver side 2, there result a desired wave 18 subject to the despread and a spectrum of interference waves 19 as shown in Fig. 10. As long as SIR (signal to

interference ratio), which is the ratio between power of the desired wave 18 and power of the interference waves 19, can be maintained at a predetermined value, necessary quality of communication can be maintained. In this case of half rate, since the SIR can be maintained at a predetermined value, the number of the interference waves 19 for maintaining the SIR to the predetermined value can be increased to a value which is twice the presently existing rate. For simplicity of explanation, the number of multiplexed channels is small in the example (presently existing) of Figs. 5 to 7 and the example (in the future) of Figs. 8 to 10 but actually the number of multiplexed channels is large (presently, 64 channels) and the number of multiplexed channels can be increased approximately twice (in this case, amounting up to 128 channels). Accordingly, if the capacity of subscribers is not increased but is left to be existing one due to lack of the number of sequences, then the automobile onboard and/or portable telephone system will be used wastefully.

[0010]

The present invention is achieved in the light of the above problems and it is an object of the present invention to provide an automobile on-board and/or portable telephone system which can increase the capacity of subscribers easily on the basis of, for example, changing of the information transmission bit

rate.

[0011]

[Means for Solving Problem]

According to the present invention, to accomplish the above object, spread codes resulting from multiplication of m orthogonal spread codes and a first PN series are assigned to channel numbers #1 to #m in the same cell, and spread codes resulting from multiplication of the same m orthogonal spread codes as above and a second PN series which is of the same series as the first PN series but have a time phase differing from that of the first PN series by a constant phase are assigned to channel numbers #(m+1) to #2m.

[0012]

[Function]

In the present invention having the above construction, the PN series are subjected to multiplication while keeping the series unchanged but changing only the time phase to generate spread codes and the thus generated spread codes are assigned to the channels, thereby ensuring that the number of channels in the same cell can be twice the number of codes of the orthogonal spread code. Accordingly, for example, when a voice signal codec having a rate which is half the existing rate becomes applicable in the future, series which are as large in number as necessary can be assigned to increase the capacity of subscribers within

a range in which the necessary quality can be maintained even when link paths in excess of m channels are set up in one cell from the viewpoint of the requisite SIR.

[0013]

[Mode for Carrying Out the Invention]

The present invention will now be described by way of example with reference to the accompanying drawings. Fig. 1 is a block diagram showing the construction of an automobile on-board and/or portable telephone system according to an embodiment of the present invention and Fig. 2 is a diagram showing a channel structure in the embodiment. In Fig. 1, reference numeral 21 designates units at the transmitter side such as a base station and 22 units at the receiver side such a mobile station including an automobile on-board telephone or a portable telephone. Denoted by reference numerals 23, 24, 25, 26, 27 and 28 are information input lines which are provided, in the units at the transmitter side 21, in correspondence to channel numbers assigned to individual users and to which information from the individual users is inputted, by 29, 30, 31, 32, 33 and 34 are spread modulators connected to the information input lines 23 to 28, respectively, and operative to perform spread processings in accordance with spread codes corresponding to the individual channel numbers, and by 35 a combiner for combining and transmitting spread signals

of users corresponding to channel numbers #1 to #2m. Of the information input lines 23 to 28 and spread modulators 29 to 34, the information input lines 23 to 25 and spread modulators 29 to 31 are in association with the channel numbers #1 to #m to constitute a first channel group of m series and information input lines 26 to 28 and spread modulators 32 to 34 are in association with the channel numbers #(m+1) to #2m to constitute a second channel group of m series. Denoted by reference numeral 36 is an despreader adapted to perform, in the units at the receiver side 22, a despread processing in accordance with a spread code of a channel assigned to each user.

[0014]

In the units at the transmitter side 21, the spread modulators 29, 30 and 31 of the first channel group are set so as to perform spread processings in accordance with the spread code corresponding to the individual channels by being supplied with parameters W1(t), W2(t) and Wm(t) representative of orthogonal spread codes (m is a number of the codes), respectively, and a parameter PN(t) representative of a PN series. The spread modulators 32, 33 and 34 of the second channel group are set so as to perform spread processings in accordance with the spread codes corresponding to the individual channels by being supplied with the same parameters W1(t), W2(t) and Wm(t) repre-

sentative of orthogonal spread codes as those for the spread modulators 29, 30 and 31 of the first channel group and a parameter PN(t-ϕ) representative of the PN series. PN(t-ϕ) of the PN series is of the same PN series as that represented by PN(t) but has a time phase which differs from that of PN(t) by a constant phase. Through this, in the automobile on-board and/or portable telephone system of the present embodiment, a maximum of 2m channels can be set on the outbound link path of one cell.

[0015]

In the units at the receiver side 22, each equipment has an despreader 36 and when the channel number of the units at the receiver side 22 shown in Fig.1 is #1, that despreader 36 is supplied with a parameter Wi(t) representative of an orthogonal spread code and a parameter PN(*) representative of the PN series, where PN(*) is

$$PN(*)=PN(t) \text{ when } i \leqq m, \text{ and}$$
$$PN(*)=PN(t-\phi) \text{ when } i \geqq m+1.$$

Then the orthogonal spread codes are multiplied by the PN series to produce spread codes and by performing a despread processing in accordance with a spread code corresponding to a channel of interest, a user signal destined for this apparatus can be repro-

duced. A channel structure for performing the above spread and despread processings is shown in Fig. 2 in the form of a table.

[0016]

The operation of the automobile on-board and/or portable telephone system will now be described. In the units at the transmitter side 21, when user information is inputted from one of the information input lines 23 to 28 at a predetermined transmission bit rate (for example, B/2 [bps]) which is the half of the rate B, a spread processing is carried out by one of the spread modulators 29 to 34 in accordance with a spread code corresponding to a channel number assigned to the user of interest and then spread signals of a plurality of users are combined in the combiner 35 and transmitted. On the other hand, when a combined spread signal is received in the units at the receiver side 22, the combined spread signal is subjected to a despread processing by the despreader 36 in accordance with a spread code of the channel number assigned to the respective user to reproduce the information at the information transmission bit rate B [bps] and the reproduced information is delivered out through an information output line 37. When the signal indicative of the user information transmitted at the halved information transmission bit rate is subjected to the spread processing, transmitted and subjected to the

despread, its waveform is changed. The operational condition of the waveform change has already been described with reference to Figs. 8 to 10 and will not be described herein.

[0017]

Accordingly, for example, when a voice signal codec having a rate which is half the presently existing rate becomes applicable in the future, channels of a maximum of 2m can be set simultaneously if the requisite communication quality can be maintained in spite of the fact that link paths in excess of m channels are set up in one cell from the viewpoint of the necessary SIR, thereby making it possible to increase the capacity of subscribers without drastically improving component units manufactured in correspondence to the existing automobile on-board and/or portable telephone system or exchanging all of the component unit with new ones. In order to maintain the communication quality from the viewpoint of the necessary SIR, a maximum value of the number of link paths allowed to be set up simultaneously in the cell can be decided on the basis of information transmission bit rates for individual users set on link paths set up in the units at the transmitter side 21 or the base station and setting of link paths for the users can be allowed within the maximum value.

[0018]

In the foregoing embodiment, the PN series by

which the orthogonal spread codes are multiplied is exemplified to have two different phases, however, the number of PN series can be determined desirably. For example, in the case where service at a very low information transmission bit rate is given as a system and the user often receives the service, the requisite quality can be maintained from the viewpoint of the necessary SIR even when link paths are set up for very many users in one cell. In such a system, three or more types of phases of the PN series by which the orthogonal spread code are multiplied can be employed instead of two types and hence the number of spread codes to be assigned can be increased to a great extent to further increase the subscriber's capacity.

[0019]

[Effects of the Invention]

As described above, according to the present invention, different phases of the PN series by which the orthogonal spread codes are multiplied are given to provide some types of PN series so that the number of channels in the same cell may be maintained at a value which is a multiple of the number m of series and therefore in the case where a voice signal codec is applied at a rate which is half the presently existing rate in the future, assignment of spread codes which are increased in number to as large a value as necessary can be achieved and the subscriber's capacity can be in-

creased without drastically altering the components within a range in which the necessary quality can be maintained even when link paths for m or more channels are set up in one cell from the viewpoint of SIR.

[Brief Description of Drawings]

[Fig. 1]

Block diagram showing the construction of an embodiment of an automobile on-board and/or portable telephone system according to the present invention.

[Fig. 2]

Diagram showing an example of the channel structure adopted in the embodiment.

[Fig. 3]

Block diagram showing the construction of a conventional automobile on-board and/or portable telephone system.

[Fig. 4]

Diagram showing an example of the channel structure in the conventional example.

[Fig. 5]

Diagram showing a spectrum signal of user information transmitted at the existing information transmission bit rate.

[Fig. 6]

Diagram showing a spread multiplexed spectrum signal obtained by subjecting the spectrum signal to spread processings.

[Fig. 7]

Diagram showing a desired wave and a spectrum of interference waves obtained by subjecting the spread multiplexed spectrum signal to a despread processing.

[Fig. 8]

Diagram showing a spectrum signal of user information transmitted at a bit rate which is half the existing information transmission bit rate.

[Fig. 9]

Diagram showing a spread multiplexed spectrum signal obtained by subjecting the spectrum signal transmitted at the half rate to spread processings.

[Fig. 10]

Diagram showing a desired wave and a spectrum of interference waves obtained by subjecting the spread multiplexed spectrum signal shown in Fig. 9 to a despread processing.

[Description of Reference Numerals]

21 units at the transmitter side

22 units at the receiver side

23, 24, 25, 26, 27 and 28 information input line

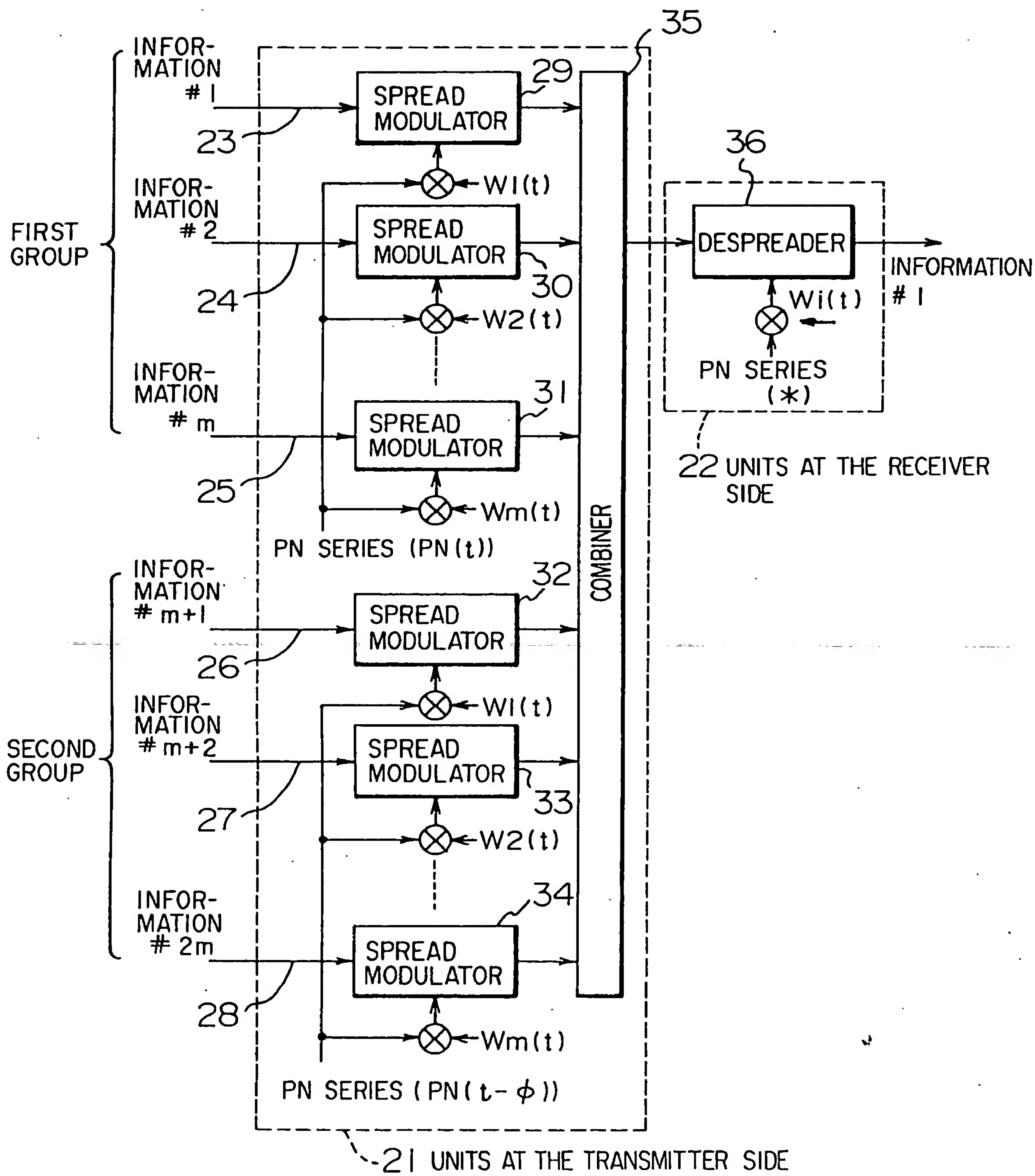
29, 30, 31, 32, 33 and 34 spread modulators

35 combiner

36 despreader

[Title of Document] Drawings

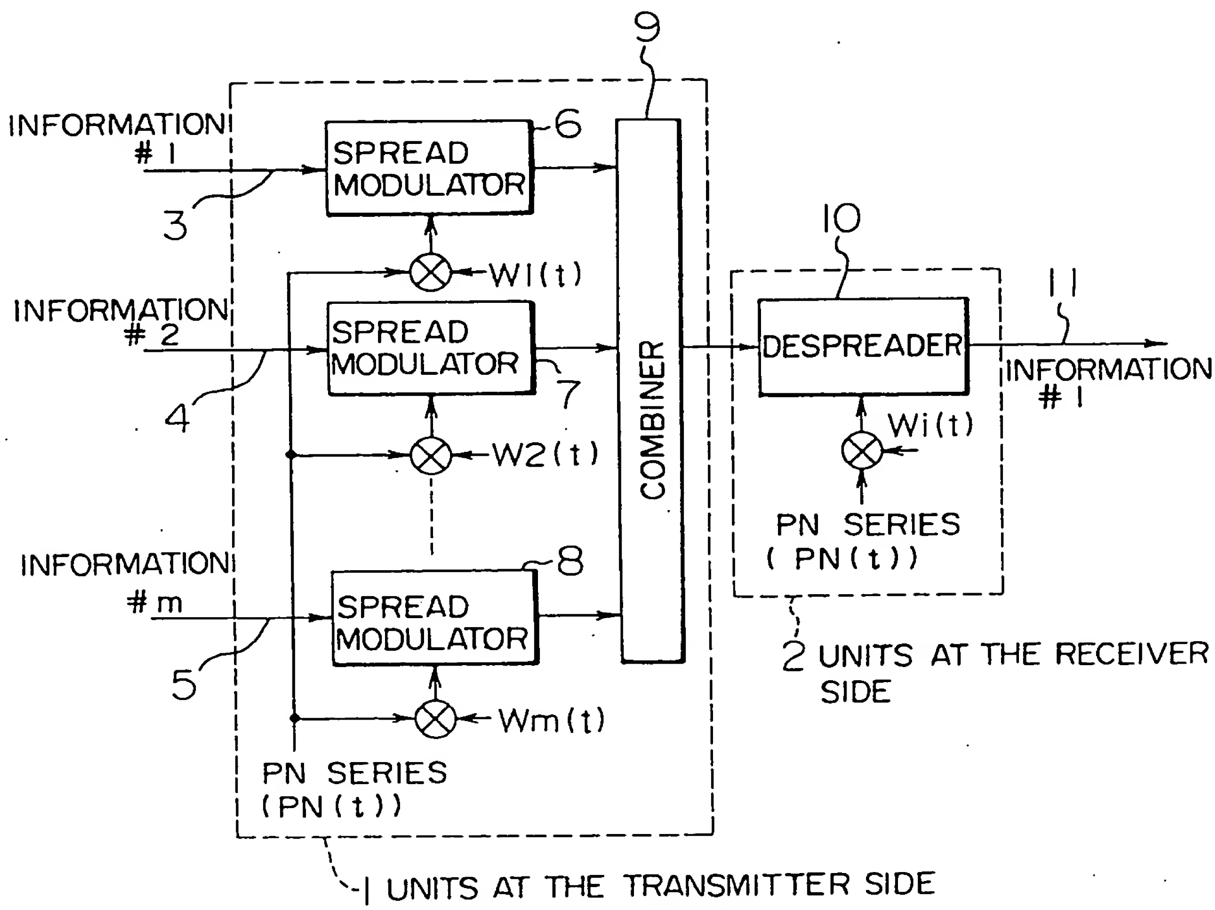
[Fig. 1]



[Fig. 2]

CHANNEL NUMBER	ORTHOGONAL SPREAD CODE	$\otimes$	PN SERIES → SPREAD CODE	
# 1	W1(t)	$\otimes$	PN(t)	FIRST GROUP
# 2	W2(t)	$\otimes$	PN(t)	
⋮		⋮		
# m	Wm(t)	$\otimes$	PN(t)	
# (m+1)	W1(t)	$\otimes$	PN$(t-\phi)$	SECOND GROUP
# (m+2)	W2(t)	$\otimes$	PN$(t-\phi)$	
⋮		⋮		
# (2m)	Wm(t)	$\otimes$	PN$(t-\phi)$	

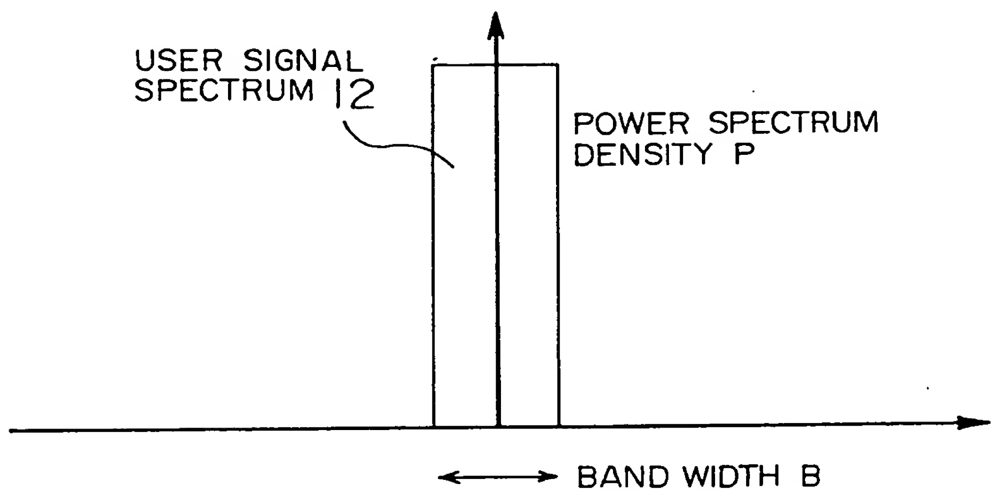
[Fig. 3]



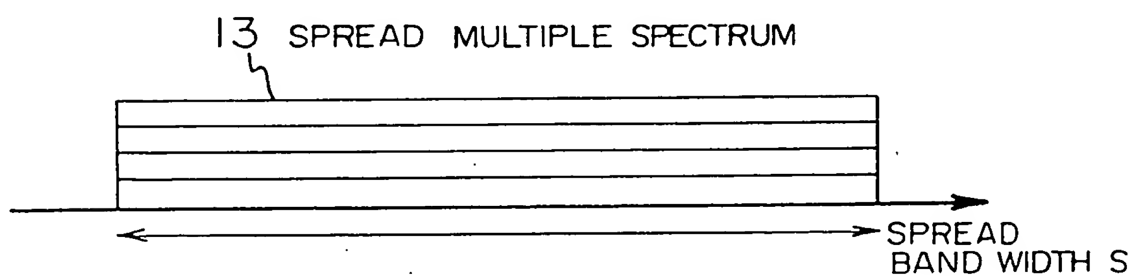
[Fig. 4]

CHANNEL NUMBER	ORTHOGONAL SPREAD CODE ⊗ PN SERIES → SPREAD CODE
#1	W1(t) ⊗ PN(t)
#2	W2(t) ⊗ PN(t)
. . .	. . .
#m	Wm(t) ⊗ PN(t)

[Fig. 5]


USER SIGNAL SPECTRUM 12
POWER SPECTRUM DENSITY P
BAND WIDTH B

[Fig. 6]


13 SPREAD MULTIPLE SPECTRUM
SPREAD BAND WIDTH S

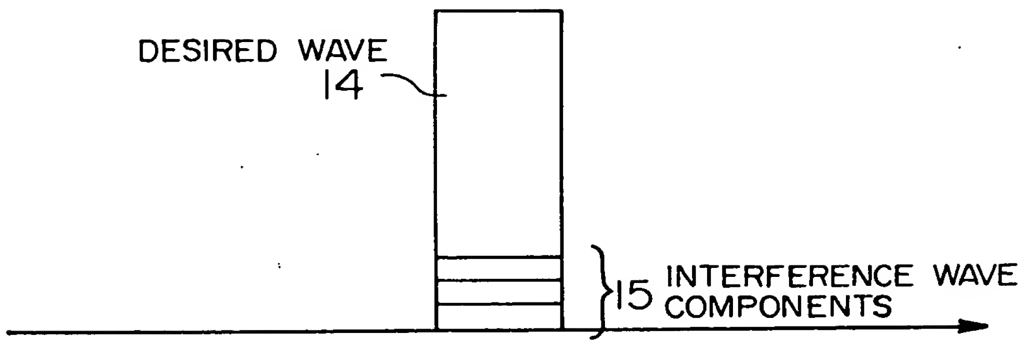
[Title of Document] Abstract

[Abstract] To provide an automobile on-board and/or portable telephone system which can increase the capacity of subscribers easily on the basis of changing of the information transmission bit rate and so forth.

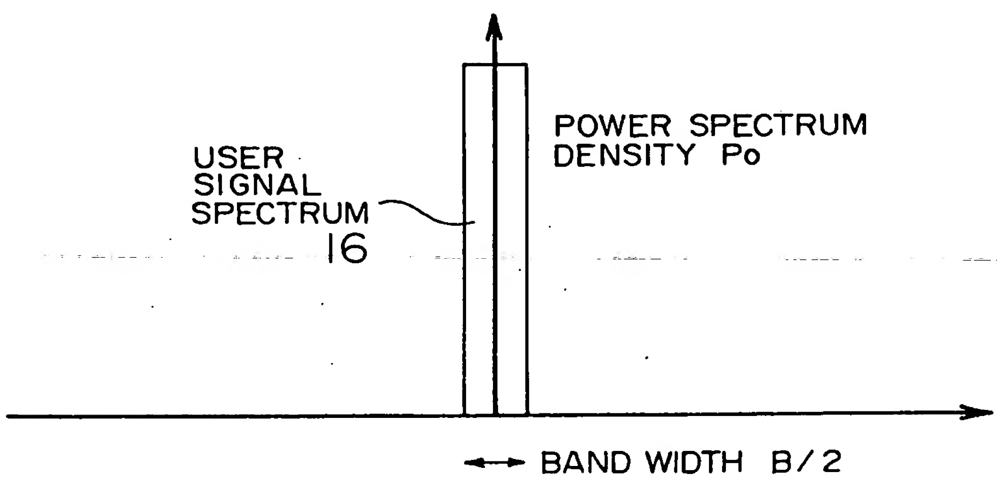
[Structure] In an automobile on-board and/or portable telephone system in which spread codes obtained by multiplying orthogonal spread codes (number of codes: m) by a pseudo-random noise series are assigned to individual channels in the same cell, some types of pseudo-random noise series are obtained by changing the phase of pseudo-random noise series by which the orthogonal spread codes are multiplied, thereby making it possible to maintain the number of channels in the same cell at a value which is a multiple of the number m of codes of the orthogonal spread codes. Through this, in the case where the transmission bit rate is halved as compared to the presently existing rate in the future, the assignment of spread codes which are increased in number to as large a value as necessary can be achieved and the subscriber's capacity can be increased within a range in which the necessary quality can be maintained even when link paths for m or more channels are set up in one cell from the viewpoint of SIR.

[Selected Drawing] Fig. 1

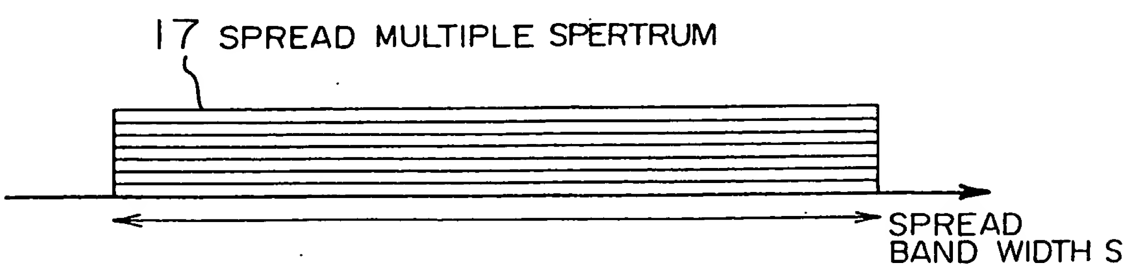
[Fig. 7]



[Fig. 8]



[Fig. 9]



[Fig. 10]